AN ALTITUDINAL SURVEY OF SPECIES OF *BEGONIA* HAVING A HORNED FRUIT[1]

by

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ABSTRACT

During the months of June, July, and August, 1973, twenty-five different species of *Begonia*, of which several belong to the section Casparya, were collected in Colombia; a significant characteristic of this section is the horned fruit. Of the eight species collected within Casparya having this fruit, seven were located above 2,000 meters. Altitudinal information subsequently were obtained from one hundred forty-five herbarium collections, of which one hundred twenty-four, or 86%, were recorded as occurring at or above this elevation. Of thirty-four species possessing this fruit types only five species have been observed to range both above and below 2,000 meters. Of the other twenty-nine species, whose distribution is more restricted, twenty-one have been observed to range from this altitude and higher; this represents 72% of the species on which data were obtained. Five additional species of Begonia have a horned fruit and are found at low elevations in Brazil. Those species belong to the largest American sections, Pritzelia and Begoniastrum; their elevations are tabulated here, also. This paper is intended only to present a survey of some altitudinal data and does not represent a complete ecological or taxonomic study of horned fruit species.

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INTRODUCTION

The Begoniaceae is primarily composed of the genus Begonia, which includes approximately 1000 species (Barkley, 1972). This genus is divided into sections varying in size from one species to one hundred or more in certain cases. Gradient analysis for elevation has been carried out by Whittaker (1967) where vegetation samples were taken along equal intervals. His findings for transects in the Great Smoky Mountains, Tennessee, indicate that certain tree species do not have sharply defined boundaries along a gradient. Rather the species show a peak density of individuals with a decreasing density at lower or higher elevations beyond the maximum. This paper presents only the elevational distribution of horned fruit species of Begonia, and tabulates some preliminary data on the average elevation of many American sections of the genus.

Species of Begonia possessing the horned fruit appear to be distributed at elevations generally greater than 2000 meters. This paper presents a tabulation and analysis of collections made by the author, held in the Gray Herbarium, and reported in the articles of Smith and Schubert (1946, 1958, and 1961), Smith and Smith (1971), Barkley (1972), and Smith (1973). Smith and Schubert (1946) provide the key to Colombian species of Begonia in their monograph. They distinguish among certain species having fruit which is either winged or horned. Their description of the latter being:

> Ovary and capsule turbinate, not winged but equally 3-horned from the upper part of the angles; stigmatic tissue usually covering all sides of the styles; capsule dehiscent at angles; staminate tepals 4.

Barkley's (1972) list of species of the Begoniaceae was also used to identify additional species placed in the section Casparya after 1961 and to determine the section to which other species belong. Collections made prior to 1946 were included in Smith and Schubert's paper, while any material at the Gray Herbarium obtained after their paper was used in this study. The additional data on horned fruit species placed in the sections Begoniastrum and Pritzelia was obtained from Smith and Smith's (1971) monograph on the Begoniaceae of Santa Catarina, Brazil. Smith's (1973) monograph on Venezuelan Begonia includes several newly described species, as well as altitude information on the distribution of other horned fruit species.

GENERAL ALTITUDINAL DISTRIBUTION OF AMERICAN BEGONIA

A survey of some literature (Smith and Schubert 1941, 1946, 1950, 1958, 1961; Smith and Smith (1971); and Smith (1973) was

TABLE 1

AVERAGE ELEVATIONS OF AMERICAN SECTIONS OF BEGONIA

SECTION	No. of Recognized Species	No. of Species Described	Lowest Elevation Recording (in meters)	Highest Elevation Recording (in meters)	Average Elevation (in meters)	Primary Geographical Distribution
Casparya Warburg	40	34*	500	3350	2280	Colombia, Venezuela
Gobenia A.D.C.	10	2	1650	2493	2070	Colombia
Barya A.DC.	3	2	1600	2500	2050	Andes, Mexico
Australes Smith & Schubert	14	3	850	3467	2030	Argentina
Lepsia A.DC.	4	3	815	2553	1850	Colombia
Eupetalum A.DC.	4	1	1675	1675	1680	Andes
Pildera A.DC.	2	1	920	2200	1640	Colombia
Ruizopavonia A.DC.	35	12	600	2400	1610	Peru
Huszia A.DC.	32	11	108	2950	1600	Andes
Knesebeckia A.DC.	34	6	415	2000	1330	Mexico
Rossmannia A.DC.	3	2	800	1900	1080	Andes
Gireoudia A.DC.	63	19	50	1980	1050	Mexico, Central America
Begoniastrum L.	103	16	233	2500	1040	Tropical America

TABLE 1 (Cont'd)

AVERAGE ELEVATIONS OF AMERICAN SECTIONS OF BEGONIA

SECTION	No. of Recognized Species	No. of Species Described	Lowest Elevation Recording (in meters)	Highest Elevation Recording (in meters)	Average Elevation (in meters)	Primary Geographical Distribution
Meionanthera A.DC.	1	1	560	1498	1030	Colombia, Ecuador
Weilbachia A.DC.	12	2	350	2000	1030	Mexico
Scheidweileria A.DC.	6	1	220	2200	990	Brazil
Podandra A.DC.	2	1	300	1400	850	Guatemala, Mexico
Cyathocnemis A.DC.	1	1	680	700	690	Peru
Doratometra A.DC.	13	8	61	1700	740	Tropical America
Pritzelia A.DC.	107	11	329	1900	660	Brazil
Bradea Toledo	11	1	100	1000	540	Brazil
Trendelenburgia A.DC.	2	1	5	1000	420	Brazil
Enita Brade	4	1	50	500	270	Brazil
Solananthera A.DC.	4	1	5	750	250	Brazil

*The 34 species listed for Casparya are not all described in the monographs; the majority of the altitudinal data was obtained from specimens at the Gray Herbarium.

TABLE 2

COLLECTIONS OF HORNED FRUIT SPECIES
MADE BY THE AUTHOR IN COLOMBIA

Species/Section	Approximate Altitude (in meters)	Department
Begonia ferruginea L. f - Casparya	2800 - 3000	Boyaca
B. killipana Smith and Schubert - Casparya	2700 - 2900	Cauca
B. hexandra Irmscher - Casparya	2700 - 2900	Cauca
B. toledana var. erubescens Smith and Schubert - Casparya	2700 - 2900	Cauca
B. urticae L. f. - Casparya	3000 - 3600 (two collections)	Boyaca & Cauca
B. libera Smith and Schubert - Casparya	1600 - 1800	Cauca
Begonia - get to be determined	2200 - 2400	Boyaca
Begonia - get to be determined	2200 - 2400	Boyaca

conducted in order to get a comparison between the elevations of horned fruit species and the normal winged fruit species of Begonia. Table 1 lists the sections which are represented by species in the monographs and includes the number of species per section, according to Barkley's list (1972), the number of species described in the literature, the lowest, highest, and average elevation recording for each section, and the geographical area where the sections are predominantly distributed.

The average elevation listed for each section is based on a simple arithmetic mean. The average elevation recordings for each species within a section were found and the mean for the section is thus based on the average for all species recorded, independent of the number of collections. Table 1 serves simply to show how other sections are distributed altitudinally in comparison to Casparya. The data are very preliminary, as indicated by the great difference in the number of species described in the monographs and the number of recognized species in each section.

The preliminary nature of these data do not allow for much interpretation though several points deserve mention. The section Casparya has the highest average elevation listing of all American sections; upon a thorough statistical analysis, where the number of collections is taken into account for each species, the average elevation for the section will undoubtedly be greater. Also, Casparya is the fourth largest section, exceeded in number of species only by Pritzelia, Begoniastrum, and Gireoudia. Two other large sections, Huszia and Knesebeckia, are characterized by many species which have a tuberous habit, though the former is found predominantly in the Andes and the latter in Mexico and Central America. Their average elevations, at this state of analyses, are very close.

RESULTS AND DISCUSSION

Tables 2, 3, and 4 show the data collected on the known species of American Begonia having a horned fruit. Table 2 includes just those species personally collected in Colombia during the three months of 1973. Table 3 compiles all data obtained for each species and includes: its section, observed number of collections, altitude, and country of collection. Table 4 categorizes the elevations of 5 additional horned fruit species occurring at low elevations near the Southeastern coast of Brazil. When the elevation was recorded as a range overlapping two of the zones used in the table, the lower end of the range was chosen for tabulation. Figure 1 presents the number of species and collections made within each altitude zone for Casparya and the other Western South American sections. It serves to graphically illustrate the discontinuity at 2000 meters.

TABLE 3

SECTIONS, SPECIES, AND ELEVATIONS
OF BEGONIA HAVING THE HORNED FRUIT

SECTION/SPECIES	ELEVATION ZONE WITH NUMBER OF OBSERVED COLLECTIONS MADE WITHIN THAT ZONE (in meters)						COUNTRY WHERE OBSERVED
	0-1000	1000-1500	1500-2000	2000-2500	2500-3000	3000-3700	
CASPARYA							
Begonia antioquiensis Rusby						1	Colombia
B. Diffusa Smith & Schubert					1	5	Colombia
B. ursina Smith & Schubert					1	1	Colombia
B. urticae L.f		1	2	8	17	13	Costa Rica to Peru
B. hexandra Irmscher					2		Colombia
B. hirta Smith & Schubert					2		Peru
B. formosissima Sandwith					2		Venezuela
B. gehrigeri L.B. Smith					1		Venezuela
B. lipolepis L.B. Smith					1		Venezuela
B. mariae L.B. Smith					1		Venezuela
B. trapa Smith & Schubert					1		Venezuela
B. ferruginea L.f				2	7	1	Colombia, Venezuela
B. cornuta Smith & Schubert				1	3		Colombia
B. killipiana Smith & Schubert				1	3		Colombia
B. trianae Warburg			2	1	1	1	Colombia
B. gamolipis Smith & Schubert				3	4		Colombia
B. udisilvestris C.DC.				6	1	2	Costa Rica, Panama
B. umbellata HBK				5	6		Colombia
B. colombiana Smith & Schubert		2		3	1	1	Colombia
B. toledana Smith & Schubert			1	5	2		Colombia, Venezuela
B. trispathulata Warburg				1			Colombia, Venezuela
B. vareschii Irmscher				1			Venezuela
B. grewiifolia Warburg				1			Colombia
B. brevipetala Warburg			1				Venezuela

SECTION/SPECIES	ELEVATION ZONE WITH NUMBER OF OBSERVED COLLECTIONS MADE WITHIN THAT ZONE (in meters)						COUNTRY WHERE OBSERVED
	0-1000	1000-1500	1500-2000	2000-2500	2500-3000	3000-3700	
CASPARYA							
B. kalbreyeri Smith & Schubert			1				Colombia
B. chlorolepis Smith & Schubert		1					Colombia
B. libera Smith & Schubert		1					Colombia
B. tetrandra Irmscher		1					Ecuador, Peru
B. valvata Smith & Schubert	1						Ecuador
B. oliveri Smith & Schubert	1						Colombia
APTERON C.DC.							
B. trujillensis Smith				1			Venezuela
HEXAPTERA Ziesenhenne							
B. oaxacana A.DC.			4				Mexico, El Salvador
UNIFORMIA Ziesenhenne							
B. heydei C.DC.	1	1		1			Guatemala, Honduras Costa Rica

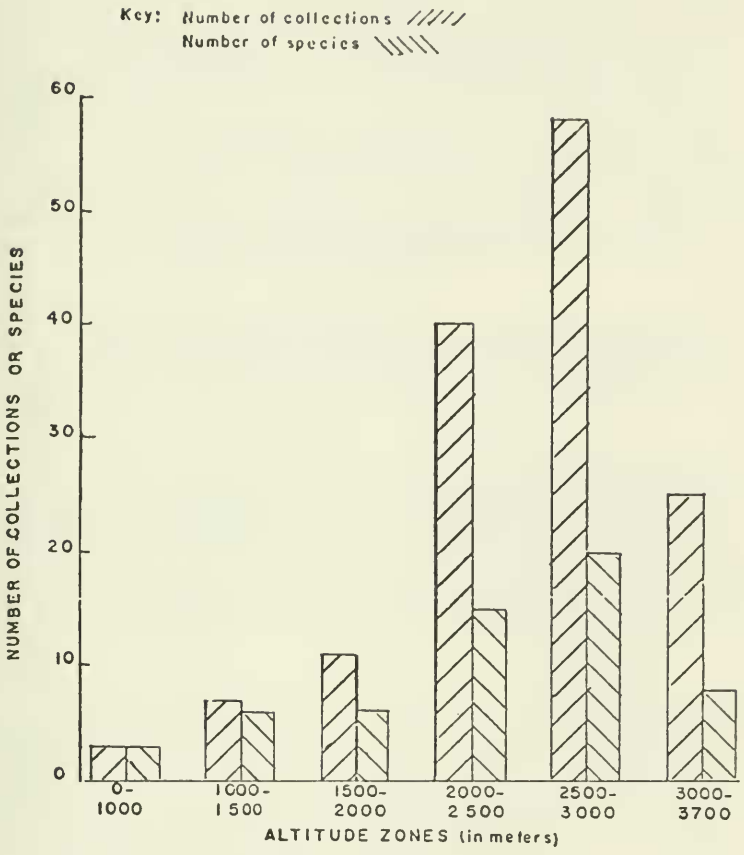

FIG. 1 – DISTRIBUTION OF SPECIES WITHIN ALTITUDE ZONES

TABLE 4

SECTIONS, SPECIES, AND ELEVATIONS OF BRAZILIAN BEGONIA HAVING A HORNED FRUIT

SECTION/SPECIES	ELEVATION ZONE WITH NUMBER OF OBSERVED COLLECTIONS MADE WITHIN THAT ZONE (in meters)					
BEGONIASTRUM	0-300	300-600	600-900	900-1200	1200-1500	1500-2000
B. hilariana A.DC.	2		1			
B. schenckii Irm. var. schenckii		5	1			
B. squamipes Irm.			2	2		
PRITZELIA						
B. catharinensis Brade		4	1		1	
B. solitudinis Brade				2		2

With these data available, a certain trend becomes apparent. Of the thirty-one species of Casparya on which data were obtained, twenty-four have been observed at 2000 or more meters in altitude. (No information was obtained on Begonia irmscheri Smith and Schubert, B. diversistipulata Irmscher, B. fuchsiifolia Warburg, B. lehmannii Smith and Schubert, B. longirostris Benthan, and B. raimondii Irmscher.) Several species within Casparya have only been collected at elevations less than this. These species are as follows: B. chlorolepis, B. kalbreyeri, B. libera, B. brevipetala, B. tetrandra, B. oliveri, and B. valvata. The data available show collections of only one specimen for each of these species. Four species of Casparya have been observed to range both above and below 2000 meters. These include B. colombiana, B. toledana, B. trianae, and B. urticae.

Collections of Casparya indicate the majority of species are found in Colombia and Venezuela, while few species have been observed in Peru and Ecuador. Though a substantial number of species have been collected in Venezuela, few collections have been made, the majority having come from Colombia.

A relatively small group of species formerly associated with the genus Semibegoniella and now included in Casparya includes B. grewiifolia, B. kalbreyeri, and B. oliveri (Barkley and Smith, personal communication). The limited collections of the above three species indicate a distribution from very low elevations to the higher ones, 2150 meters, 1600 meters, and 150 meters, respectively. (B. irmscheri was also included in Semibegoniella and is now placed in Casparya though no data were obtained on this species.)

Of all the species having a horned fruit, B. urticae has been the most abundatly collected, and has the widest distribution. B. urticae also is one of the most wide ranging of all American Begonia having been collected from Costa Rica to Peru. With the data observed on this species, thirty-eight of the total forty-one collections were made well over 2000 meters, for B. urticae is found most abundantly between 2500-3700 M.

Information was obtained on three other small sections with species having a horned fruit. The limited data observed on the Central American sections Hexaptera and Uniformia show a majority of collections have been made below 2000 meters, contrary to the recordings of most South American Casparya. Particular reference is to B. oaxacana of Hexaptera and B. heydei of Uniformia. The recently described species B. trujillensis, placed in the section Apteron, was located at 2300 meters in Venezuela. (No information was obtained on B. bakeri C.DC. of Auriformia.)

A difference in the morphology of the fruit is found in B. oaxacana and B. udisilvestris which deserves mention. Unlike the

majority of species in Casparya and the monotypic sections Uniformia and Apteron, which all fit the established definition of a horned fruit, these two above-mentioned species are not specifically characterized by the same form of the horned fruit. Smith and Schubert (1958) provide a description of the capsule of B. oaxacana: "...wings 3 or sometimes up to 6, subequal, narrow, angled at middle or somewhat above, giving the fruit a rhombic or obovate outline..." Also, for B. udisilvestris: "Capsule erect, ovoid, attenuate into slender beak, wings equal, very narrow." In these definitions, horned is not the descriptive word; this suggests some difference from species whose capsule is described as horned. It appears that the morphology of these fruits represents an intermediate form between the common winged type and the actual horn.

Thus, the majority of species possessing a horned fruit are generally observed at an elevation between 2000 and 3700 meters above sea level. The 2000 meter elevation zone is not just an arbitrary designation; these species are found more abundantly at or above this altitude, which determines this area as the most probable location for observing them. The specific environmental factors contributing to this distribution cannot be stated for data on environment was not collected and correlated with these plants. Those species observed at lower elevations are few in number and have not been observed with the frequency of the higher altitude ones. It appears that the horned fruit species are more successfully adapted to the higher elevations than to the lower elevations.

The five species occurring in Brazil that have a horned fruit differ significantly in many respects from species of Casparya. The styles have been observed to differ in the branching pattern. Species in Casparya are irregularly branched while the five Brazilian species are regularly bifid (Smith, personal communication). Table 3 shows the elevations where collections were made; the majority of which were located between 300 and 1200 meters, which is a much lower altitudinal range than for Casparya. Morphological differences also are found in two of the species in Begoniastrum; B. hilariana and B. schenckii have a rhizomatous habit. All of the species observed in Casparya have upright habits.

There is no question that the occurrence of horned fruit species placed in Begoniastrum, Pritzelia and Casparya causes one to question the taxonomic significance of the horned fruit. The altitudinal distribution of Casparya though is suggestive of a correlation with the horned fruit, thus serving to support this trait as a valuable taxonomic character, particularly since species in this section are found at some of the highest elevations of all known American Begonia, as Table 1 indicates. Also, the frequency of the horned fruit in comparison to the normal winged type is extremely rare from a percentage standpoint, though

the section Casparya is relatively large. Even with these apparent similarities, a considerable amount of taxonomic work remains to be done.

One other species in the Begoniaceae is known to have a horned fruit, though no altitudinal information was obtained on it. Symbegonia sanguinea Warburg possesses a horned fruit similar to those found in the majority of American Begonia, though, as with all Symbegonia, is restricted to New Guinea. To my knowledge, this species is the only member of the Begoniaceae having a horned fruit in a geographical location other than Central and South America.

There are five sections with species characterized by this particular fruit type, being: Casparya, Hexaptera, Apteron, Auriformia and Uniformia. The latter four sections here are small, though the species observed within these sections possess a horned fruit, or one that is morphologically similar. The five species with a horned fruit found in Begoniastrum and Pritzelia are the exception since these two large sections are characterized by the normal winged type fruits found in the majority of all Begonia. Several questions arise from the information presented. Is there any relationship between the horned fruit species in Begoniastrum and Pritzelia and those in Casparya? Also, does Symbegonia sanguinea have any affinity to the American horned fruit Begonia, or has the horned fruit evolved independently in both geographical locations?

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